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CONTRIBUTIONS OF ANTICIPATION TIMING AND ANAEROBIC POWER TO BATTING PERFORMANCE IN SLOW PITCH SOFTBALL

A Thesis
Presented to
The Faculty of the Department of Human Performance
San Jose State University

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

By
Heidi A. York
May 1995

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ABSTRACT

CONTRIBUTIONS OF ANTICIPATION TIMING AND ANAEROBIC POWER TO BATTING PERFORMANCE IN SLOW PITCH SOFTBALL

by Heidi A. York

Batting in slow pitch softball represents a unique sport situation due to the speed and inclination of the pitch. The speed of the pitch is slow while the optimal swing is ballistic. The study was conducted in order to understand more about the components of batting performance in slow pitch softball.

Nineteen female slow pitch softball players were tested for anaerobic power using the Wingate Anaerobic Test and anticipation timing accuracy using a Bassin Anticipation Timer. Absolute peak power was found to be significantly correlated with batting average ($r = .60$, $p < .001$). Absolute mean power also demonstrated a strong relationship with batting average ($r = .55$, $p < .02$). None of the anticipation timing error scores was significantly related to batting average.

It was concluded that slow pitch softball players wishing to improve batting average should probably focus on increasing anaerobic power output rather then anticipation timing accuracy.

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Finally I would like to thank my chosen family. The encouragement received was well appreciated. Completion of a thesis requires support and encouragement from family and friends. I feel honored to have such a special person in my life to help me through the hard times and to share the good times with. Thanks for always being there for me.

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Chapter 1

INTRODUCTION

Slow pitch softball was first developed as a sport in the 1950s in order to introduce more people to recreation and more offense into the game of softball (Blucker & Graf, 1984). Slow pitch softball has evolved into a sport with its own rules and strategies separate from fast pitch softball. It has become popular because it is a game where almost anyone can participate. As its name implies, the speed of the pitch is slow and is perceived as an easy target to hit. The game is not dominated by pitchers as the emphasis is on batting ability and defensive skills. Although highly competitive levels of play exist, the bulk of participants play for recreational purposes.

In 1933 the Amateur Softball Association (ASA) was formed and became the national governing body for amateur softball in America. In 1993 the ASA had over 263,000 teams participating in the game ('94 ASA Guide and Playing Rules, 1993). The ASA conducts leagues which include fast pitch, modified fast pitch, slow pitch, and 16-inch slow pitch softball. This organization oversees competition for all ages ranging from youth to seniors. Championships and tournaments for men, women, coed, youth, and senior teams are offered. In 1994 there were 41 ASA-sanctioned national championships in slow pitch softball alone ('94 ASA Guide and Playing Rules, 1993).

The City of San Jose first offered recreational fast pitch softball in 1933. The slow pitch softball leagues came into existence in 1972 (J. M. Pletsch, personal communication, February 3, 1994). Participation in the slow pitch softball leagues has grown since then. Currently, the City of San Jose offers slow pitch softball leagues for men, women, and coed teams. During the

1992/93 season the City of San Jose had 761 teams registered for a total of 10,654 players (J. M. Pletsch, personal communication, February 3, 1994). Of these teams, approximately 70 teams were women's and 91 were coed teams. Since 1972, female softball players have increased to 1,597 participants (J. M. Pletsch, personal communication, February 3, 1994).

Slow pitch softball differs from fast pitch softball and baseball in several respects. Differences include pitching, batting, defensive positions, playing fields, and ball size. The emphasis in slow pitch softball is on hitting and defensive skills rather than pitching.

Due to the type of pitch, slow pitch softball is a hitter's game. Batting averages of .500 and higher are common (Carriero, 1984) and games are usually high scoring. In slow pitch softball the pitch is thrown underhand at an arc between 1.83 and 3.66 m high. It takes approximately 1.5 s for the ball to travel from the pitcher's hand to home plate in a 3.66 m arc (Carriero, 1984). Compare this with a baseball pitch where the hitter has less than .5 s to respond to the pitch. With the high arcs in slow pitch softball the ball approaches home plate at an inclination of approximately 30° at a 3.66 m arc. Since coaches tend to recommend a level swing, the task of hitting in slow pitch softball needs to be precise due to the angle of the pitch relative to the swing. The challenge in slow pitch softball is to be consistently successful by hitting line drives and placing hits.

Slow pitch softball is a unique sport situation where the stimulus (pitched ball) is moving at a slow rate of speed yet the proper motor response is ballistic. Bunting is not allowed, therefore hitters need to perform a full swing. Power in this case comes from the batter's ability to generate explosive movement.

Compared to fast pitch softball, the rebound of the ball with the bat is lower in slow pitch softball. Striking a slow moving object may be deceiving as many novice players may swing slowly to correspond with the slow speed of the pitch. Many female slow pitch softball players have made the transition from fast pitch softball where the speed of the pitch is approximately 23.69 $m{\bullet}s^{-1}$ (Messier, 1982). Previous experience for males usually includes baseball where the speed of the pitch is approximately 39.69 $m{\bullet}s^{-1}$ (Pecci, 1986). The approximate speed of the pitch in slow pitch softball is 9.2 $m{\bullet}s^{-1}$ (Carriero, 1984). Proper timing of the swing of the bat with the pitch is essential in baseball and softball. Considering that the speed of the pitch is much slower in slow pitch softball than fast pitch softball or baseball, reaction time is not usually a factor. However, the ability to properly estimate the arrival of the pitch into the strike zone may lead to higher batting averages.

Baseball pitchers use an overhand throw from an elevated mound whereas both fast pitch and slow pitch softball pitchers use an underhand throw from a level surface. In fast pitch softball the pitch usually arrives at home plate from an approximate level surface. When a baseball pitch arrives at home plate it is usually at a downward inclination due to the overhand pitch from an elevated mound. Although the pitch in slow pitch softball is underhand, it also arrives at home plate at a downward inclination because of the required arc.

Slow pitch softball also differs from baseball and fast pitch softball in defensive positions. In slow pitch softball there are 10 defensive players. Either four outfielders or three outfielders with one roving fielder is used. The open areas in left- and right-centerfields that are available in baseball and fast pitch softball may be covered by outfielders in slow pitch softball. This 10th fielder may cut off hits since he or she may be positioned anywhere on the playing field. The infielders in slow pitch softball will usually play behind the base path as bunting is not allowed. This also may allow more ground balls to be cut off and not become hits. Refer to Figure 1 for a diagram of defensive positions in slow pitch softball.

Differences also exist between slow pitch softball and fast pitch softball or baseball for the playing field and equipment. The distance between the pitcher's mound and home plate is 15.24 m in slow pitch softball. This is longer than the 12.19 m distance used in fast pitch softball and shorter than the 18.29 m distance used in baseball. The bases in slow pitch softball are 19.81 m apart compared to 18.29 m in fast pitch softball and 27.44 m in baseball. Balls used in slow pitch softball differ from those used in fast pitch softball. The 30.48 cm ball that is used in fast pitch softball is also used in men's and coed slow pitch softball (male batters only). A smaller and lighter 27.94 cm ball is used in women's and coed slow pitch softball (female batters only).

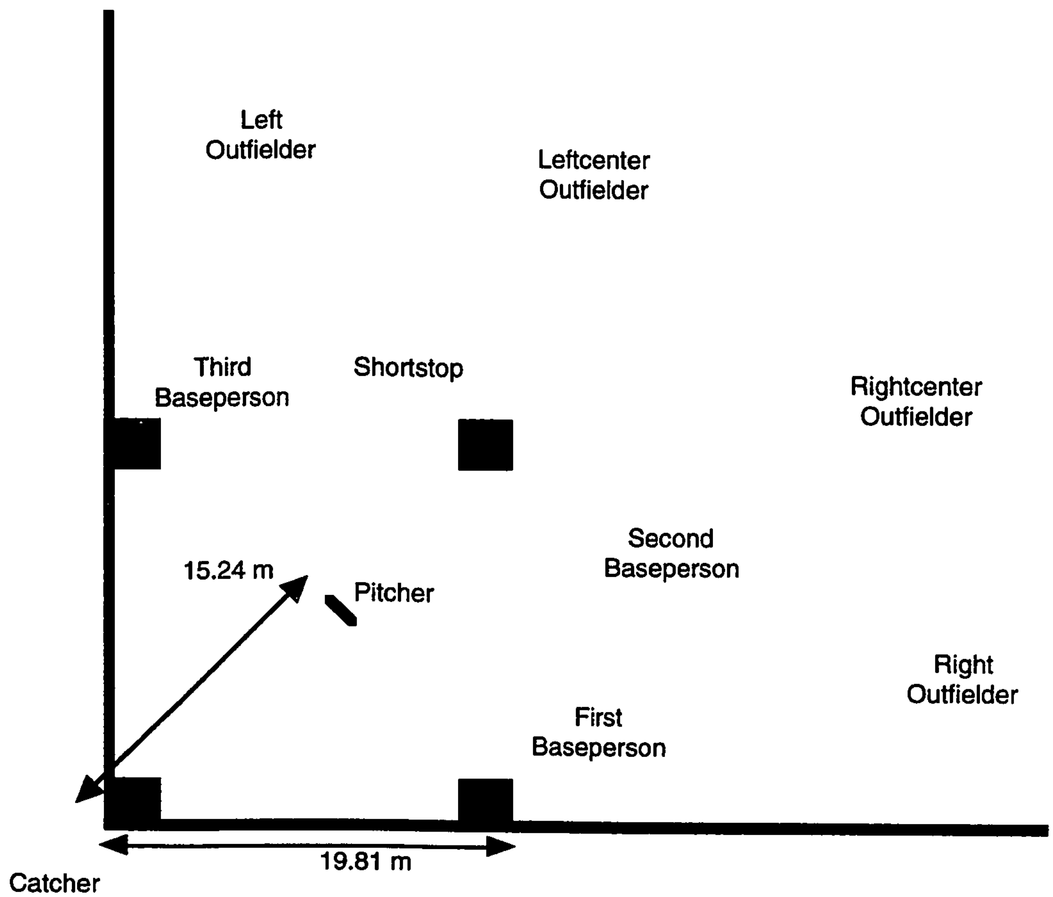
Striking activities have long been considered complicated sport skills. Batting is a complex sport skill as it involves all of the major muscle groups of the body. It is an open skill as it occurs in an environment in which the relevant factors are moving; the hitter must respond to the limited number of pitches thrown. Pitchers may try to distract the hitter by varying the height and location of the pitch, an excessive wind-up, and excessive spin of the ball.

Problem Statement

The purpose of the study was to determine the extent to which receptor anticipation timing and anaerobic power contribute to batting performance in slow pitch softball.

Figure 1

Defensive positions in slow pitch softball



Approach to the Problem

Female subjects were recruited and measured for receptor anticipation timing and anaerobic power during the City of San Jose's 1994 summer softball season. During the summer softball league batting statistics were recorded for each subject. The contributions of receptor anticipation timing and anaerobic power to slow pitch softball batting performance were determined.

Hypotheses

The null hypotheses include the following statements.

1. Receptor anticipation timing does not contribute to slow pitch softball batting performance.
2. Anaerobic power does not contribute to slow pitch softball batting performance.
3. Receptor anticipation timing and anaerobic power do not combine to contribute to slow pitch softball batting performance.

Limitations

The factors that were not controlled during the study include the following:

1. the motivation level of each subject during game situations and testing periods;
2. the amount of practice and coaching assistance received by subjects;
3. the dietary, drug, or stimulant intake prior to game situations and testing periods;
4. and previous softball experience (fast and slow pitch softball).

Delimitations

The study was delimited to:

1. women who participated in at least four games and had at least 10 plate appearances in the City of San Jose's 1994 recreation league summer softball season;
2. and subjects who had at least one year of experience playing slow pitch softball.

Assumptions

The following assumptions were made for the purpose of the study.

1. Batting statistics were recorded accurately and objectively.
2. Subjects were highly motivated to perform to the best of their ability during game situations and laboratory testing.

Definition of Terms

The following definitions were used in the study.

Absolute power. For the purpose of the study, absolute power refers to the power output in a given time and is measured in watts. This term can be used in conjunction with peak or mean power output.

Anaerobic power. For the purpose of the study, anaerobic power is the alactic phosphogen component of anaerobic energy release (Tharp, Newhouse, Uffelman, Thorland, & Johnson, 1985). The Wingate Anaerobic Test was utilized to measure anaerobic power.

Batting average. For the purpose of the study, batting average is the number of hits divided by the number of official at-bats a batter achieves (ASA Scorer's Manual, 1992). It represents the success of a hitter. Batting statistics were recorded by the investigator at softball games. A minimum of 10 plate appearances were used to determine batting average.

Peak power. For the purpose of the study, peak power refers to the maximum power generated during a 5 s period. The SMI Power™ software program (Sports Medicine Industries, Inc., St. Cloud, MN) calculated the maximum power generated during a 5 s period.

Mean power. For the purpose of the study, mean power refers to the average power generated during a 30 s period. The SMI Power™ software program (Sports Medicine Industries, Inc., St. Cloud, MN) calculated the average power generated during a 30 s period.

Receptor anticipation timing. For the purpose of the study, receptor anticipation timing is the rapid acquisition of a moving target whose future track is displayed ahead (Poulton, 1957). The prediction of the duration of response movement is included. Subjects in softball batting must be able to predict two events for success: their own movement time and when the ball will arrive at the contact point. A Bassin Anticipation Timer by Lafayette Instruments was used to measure anticipation timing.

Relative power. For the purpose of the study, relative power refers to the power output divided by body weight and is measured in watts per kilogram bodyweight (w•kg BW^{-1}). This term can be used in conjunction with peak or mean power output.

Importance of the Study

Injuries are a primary topic for research in slow pitch softball (Loosli, Requa, Ross, & Garrick, 1988; Wheeler, 1984; Wheeler, 1987). Other studies concerning slow pitch softball include coaching behaviors and player's attitudes (Senne, 1987), ritual communication (Larson, 1988), practice drills

(Greathouse, 1986), program comparison (Guthrie, 1982), and response time (Israel & Brown, 1981). However, this investigator was unable to locate scientific research concerning batting in slow pitch softball.

Batting in slow pitch softball is a unique sport situation. The goal in slow pitch softball is to score more runs than the opponent. The game is not dominated by pitchers but rather by the hitters. Batting skill is therefore significant because it is the primary offensive means of scoring. It is a unique skill where the pitch (stimulus) is moving at a slow rate of speed and the optimal motor response is fast and powerful. Some novice players will incorrectly respond with a slow bat swing due to the slow speed of the pitch.

Batting skill has been studied in baseball and fast pitch softball, however it has not been studied in slow pitch softball. Even though slow pitch softball is primarily a recreational sport, it is worthy of study due to the high rate of participation. Over 2 million adults participate in the game of slow pitch softball each year (Academic American Encyclopedia, 1993). This study was conducted in order to understand more about the components of successful batting in slow pitch softball.

Chapter 2

REVIEW OF LITERATURE

The purpose of the study was to determine the extent to which receptor anticipation timing and anaerobic power contribute to batting performance in slow pitch softball. The following chapter is devoted to examination of previous literature regarding receptor anticipation timing and anaerobic power.

Anticipation Timing

Anticipation timing is any motor response situation that requires performers to coordinate a movement in response to a stimulus (Magill, 1989). Batting in slow pitch softball involves both receptor and effector anticipation as described by Poulton (1957). Effector anticipation is the prediction of the nature and size of muscular contractions needed in order to perform a skill. In batting, subjects need to be able to predict their own movement time and when to initiate that movement. Receptor anticipation involves effector anticipation and the prediction of the moving target whose future track is displayed ahead. An approaching stimulus event is previewed and one is able to respond appropriately.

Wrisberg, Paul, and Ragsdale (1979) showed that receptor anticipation of males was more accurate than that of females. Eighty adult subjects were divided into two groups with 20 males and 20 females in each group. A Bassin Anticipation Timer (BAT) with a constant foreperiod of 1 s and trials with a constant speed of 402 $cm \cdot s^{-1}$ (9 mph) was utilized. One group received knowledge of results while the other group did not. It was found that males had significantly ($\underline{p} < .05$) lower absolute error than females. Males also displayed greater consistency (lower variable error) than females ($\underline{p} < .001$). However, another study noted that gender is not an appropriate variable to be examined alone but rather real world movement experience should also be investigated (Del Rey, Wughalter, & Whitehurst, 1982). This study used a set up similar to Wrisberg, Paul, and Ragsdale and utilized 60 females with and without experience in open sport skills. The experienced subjects performed with less error and it was concluded that characteristics other than gender should be acknowledged.

Magill (1989) noted that there appears to be an inverted-U relationship between the rate of speed of an oncoming object and the response accuracy associated with intercepting that object. This is contradictory to the speed-accuracy tradeoff where if there is an increase in speed there is a decrease in accuracy. It appears that slow moving objects tend to have an increase in timing error.

In baseball, the speed of the pitch is high and there is less time to react compared to fast or slow pitch softball. Mikel (1984) examined the relationship of coincidence anticipation timing to batting ability in baseball. Subjects consisted of 20 male college varsity baseball players. A BAT, Automatic Performance Analyzer, and photocell sensors were combined to measure anticipation timing and movement time. Batting ability was determined by a hitting productivity rating chart. A strong negative relationship ($\underline{r} = -.75$, $\underline{p} < .001$) was found between anticipation timing error and successful baseball batting ability. In baseball the average speed of a pitch is 39.69 $m \cdot s^{-1}$ (Pecci, 1986). However, the research conducted on slower moving objects has yielded greater errors in anticipation timing.

Newell, Carlton, Carlton, and Halbert (1980) examined velocity as a factor in movement timing accuracy. Three experiments were conducted in order to understand more about timing error as a function of increases in movement velocity. In the first experiment six college students were required to move a slide through the target distance in a time as close as possible to the target time. Movement time and movement distance varied in order to present the five average velocities of 5, 7.5, 10, 15, and 25 $cm \cdot s^{-1}$. It was found that the 5 $cm \cdot s^{-1}$ velocity produced significantly ($p < .05$) greater error than the 7.5, 15, and 25 $cm \cdot s^{-1}$ velocities.

The second experiment in this study focused on high velocity movements. The apparatus and procedures were identical to those in the first experiment. Subjects were another five college students. Target distances were 12.5 and 60 cm. Target time was 50, 70, 85, and 95% of the subject's maximum velocity. Subjects performed 40 trials at the four velocity conditions for the two distances. The average maximum velocity for the 12.5 and 60 cm distances was 195 and 337 $cm \cdot s^{-1}$, respectively. It was again found that timing error decreased as average movement velocity increased.

The third experiment in this series examined the full range of the movement velocity continuum. The apparatus and procedures were identical to those in the first two experiments and subjects were an additional six college students. The four average velocities presented were 5, 25, 150, and 225 $cm \cdot s^{-1}$. It was found that timing error decreased as average movement velocity increased. These investigators demonstrated a systematic decrease in timing error as movement velocity increased.

Ball (1992) examined the interactive effect of velocity on coincident timing performance. Subjects were required to move their right hand between two touch sensitive plates with a corresponding target. Target velocity was 10 and 20 cm•s^{-1} and movement distance was 30 and 60 cm. Eight blocks of 25 trials were performed by 16 men and women. It was found that the lowest variable error occurred at the fastest velocity while the highest variable error occurred with the slowest velocity.

These studies tend to support an inverted-U relationship between an oncoming object and the response accuracy associated with intercepting that object. Or perhaps a linear relationship exists involving high error with slow speed and low error with high speed. Thus, timing error that corresponds with slow moving targets seems to be higher than with faster moving targets. The explanation for this phenomenon is unsettled. It is possible that the ability to judge the passage of time is a skill that may be not well learned. If this is true, it may explain why players have trouble adapting to the timing of the pitch in slow pitch softball after experience in fast pitch softball or baseball. The aforementioned studies utilized speeds of under 337 and 3,969 cm•s^{-1}. These speeds may be inappropriate for comparison with slow pitch softball as the speed of the pitch is approximately 920 cm•s^{-1}.

Anaerobic Power

The Wingate Test was first introduced in 1974 at the Wingate Institute for Physical Education and Sport in Israel. It was designed to be a simple, inexpensive test of anaerobic work. The test requires a subject to pedal or arm crank at a maximal level for 30 s against a constant force (Bar-Or, 1987). Three indices of anaerobic performance are measured: (a) peak power, (b) mean power, and (c) fatigue index. Bar-Or defined peak power as the ability of the muscles to produce a high amount of work in a short period of time. Peak power represents the highest mechanical power generated in a 5 s period (McArdle, Katch, & Katch, 1991; Bar-Or). Mean power is the average power sustained throughout the test (Bar-Or). It reflects the ability of the muscle to sustain a high power output during the 30 s test. Bar-Or also defined fatigue index as the degree of power drop-off during the test.

It has been suggested that a higher braking force is needed to maximize peak power (Bar-Or, 1987; Bradley, 1991; Doton & Bar-Or, 1983; Patton, Murphy, & Frederick 1985; Shaw, Davy, Coleman, & Kamimukai, 1988). In Table 1 increasing power outputs and increasing workloads are compared. Bradley (1991) noted that relative peak power output was highest when using a resistance of 105 g•kg BW^{-1}. In a study of 46 female subjects, of which eight were collegiate softball players and 26 were nonathletes, peak power of the softball players averaged $9.93 \pm .95$ watts•kg BW^{-1}. Average peak power of the nonathletes was 9.79 ± 1.05 watts•kg BW^{-1}. Athletic college age females were able to generate higher power outputs at loads greater then 75 g•kg BW^{-1}.

Shaw et al., (1988) found that peak power could be elicited with a load of at least 90 g•kg BW^{-1}. This investigation involved four workloads of 70, 80, 90, and 100 g•kg BW^{-1}. Subjects consisted of 11 female intercollegiate softball players. Refer to Table 1 for the peak power outputs generated at the four workloads. The two higher workloads were significantly ($\underline{p} < .05$) different from the two lower workloads. The 100 g•kg BW^{-1} workload produced higher power outputs, however, there were no significant differences between the 90 and 100 g•kg BW^{-1} workloads. It was therefore concluded that a force of at least 90 g•kg BW^{-1} is needed to obtain peak power output.

Table 1

Increasing Peak Power Output with Increasing Workloads for the Wingate Test in Female Subjects*

		Workloads (in g•kg BW^{-1})							
Study	Subjects	70	75	80	85	90	95	100	105
Bradley (1991)	N = 46 college age		9.58 ±.91		10.09 ±.94		10.23 ±1.0		10.57 ±1.33
Shaw et al. (1988)	N = 11 college softball players	9.1 ±.7		9.6 ±.8		10.8 ±.8		11.1 ±1.1	

* - Peak power output expressed in watts per kilogram body weight

Nineteen physically active male subjects were tested 11 times to determine the resistance loads that elicited the highest peak and mean power during the Wingate Test (Patton et al., 1985). Eleven trials with resistance ranging from 3.23 to 6.76 joules/pedal revolution/kg BW were performed on a Monark ergometer. The load which produced the highest peak power was 5.65 ± .53 joules/rev/kg BW. The highest mean power was elicited with a load of 5.53 ± .53 joules/rev/kg BW. The highest power decrease was produced by the 5.59 ± .53 joules/rev/kg BW. A paired t test was used to compare this workload with the standard workload of 4.41 joules/rev/kg BW (75 g•kg BW^{-1}). Peak power and mean power absolute values were significantly ($p < .001$) higher for the 5.59 joules/rev/kg BW workload. Peak power was 770 ± 94 and 888 ± 114 watts for the 4.41 and 5.59 joules/rev/kg BW workloads, respectively. It was concluded that a higher workload produced a higher power output.

Beld, Skinner, and Tran (1989) also examined load optimization for the Wingate Test. Subjects consisted of 10 untrained men, eight endurance athletes, and four power athletes. The Wingate Test was performed with loads of 75, 81, 87, 93, 99, and 105 g•kg BW^{-1}. The highest resistance of 105 g•kg BW^{-1} elicited the highest peak power output among all subject types. There were no differences among the workloads in mean power output. The investigators suggest that the optimal resistance for peak and mean power are probably higher then 105 g•kg BW^{-1}.

Research tends to support the idea that the optimal load for the Wingate Test is greater for peak power output when the variable of interest is peak power output only. While these greater braking forces may optimize peak power output, mean power output may not be increased with the greater loads. Table 1 compares peak power output for various resistances for female subjects. Output continues to increase as workload increases. However, there is no standard abbreviated version of the Wingate Test lasting less then 30 s. Bar-Or (1987) suggested that a shorter version of the Wingate may be indicated for use with disabled and aged populations. Optimal loads for peak power output may be higher than the 75 g•kg BW^{-1} first recommended when the Wingate Test was developed. Further research needs to be conducted in this area in order to determine the optimal resistances for peak and mean power outputs when one or both variables are of interest.

Summary

Batting skill has been studied in baseball and fast pitch softball, however it has not been studied in slow pitch softball. Batting in slow pitch softball is a unique sport situation where the pitch is moving at a slow rate of speed and the optimal motor response is ballistic. Since a batter has approximately 1.5 s to respond to a pitch, it is likely that reaction time does not play a critical role. However, one's ability to visually track a pitch and make optimal contact may play a crucial role in successful batting performance.

Magill (1989) noted that there appears to be an inverted-U relationship between the rate of speed of an oncoming object and the response accuracy associated with intercepting that object. It is possible that the speed of a pitch in slow pitch softball is in the middle of the inverted-U relationship. The studies reviewed found reduced timing error with speeds of 25 to 337 cm•s^{-1} and 3,969 cm•s^{-1}. The speed of a pitch in slow pitch softball is approximately 920 cm•s^{-1} (Carriero, 1984).

A ballistic movement of less then 5 s relies primarily upon anaerobic responses. Batting is one such skill that requires a performer to depend upon quick movement to be successful. The Wingate Test was designed to measure such anaerobic responses. The optimal workload which produces the highest peak power output has yet to be determined. It may be possible that the highest peak and mean power outputs are produced at different workloads. The standard workload of 75 g•kg BW^{-1} has been in use since 1974. In a study attempting to establish norms 68 college females were tested and the average peak power output was 7.61 ± 1.04 watts•kg^{-1} (Maud and Shultz, 1989).

Chapter 3

METHODS

The purpose of the study was to determine the extent to which receptor anticipation timing and anaerobic power contribute to batting performance in slow pitch softball. The methods of the study are presented in this chapter.

Subjects

Volunteers were recruited from one women's recreational slow pitch softball league held in the City of San Jose. Flyers (Appendix A) were handed out to prospective subjects. The selection criteria for subjects were: (a) female, approximate age 30 to 40 years, (b) at least one prior season of slow pitch softball experience, (c) participating in the summer 1994 slow pitch softball season, and (d) apparently healthy. All subjects were right-handed hitters. Twenty-seven subjects were recruited; however, only 19 subjects were able to complete the study. All subjects completed an informed consent form (approved by San Jose State University's Institutional Review Board: Human Subjects) prior to data collection in the laboratory (Appendix B).

Apparatus

Receptor anticipation timing was measured using a Bassin Anticipation Timer (BAT) from Lafayette Instruments. The BAT consists of four 16-lamp runways attached end to end and measuring 295 cm in total length. At the end opposite the subject, an amber warning light was used to have the subject prepare for the following trial. Along the runway red lights appeared one after the other giving the illusion of movement. The experimenter's control box consisted of a thumbwheel to set speed and a knob to adjust foreperiod. The lights illuminated according to a set time schedule as determined by the investigator. The BAT recorded the difference in time between the final light illuminating and the response button being depressed. A hand-held response button was utilized.

Anaerobic power was measured using the Wingate Anaerobic Test. This test was performed on a 818 Monark cycle ergometer equipped with adjustable toe clips, handlebars, and seat. Resistance on the cycle ergometer was manually set at 75 g•kg BW^{-1} (MacDougall, Wenger, & Green, 1982). An Opto-Sensor™ (Sports Medicine Industries, Inc., St. Cloud, MN) was mounted on the cycle ergometer near the flywheel. The sensor measured revolutions utilizing reflective markers placed at increments of 1/16 of the flywheel. The sensor was computer interfaced using SMI Power™ v1.02 software program (Sports Medicine Industries, Inc., St. Cloud, MN) housed in a PC computer. Characteristics of the subject being tested were entered and power output was then calculated. Indices measured included maximum power, mean power, fatigue index, and total work performed. A computer printout from each Wingate test was generated and a sample appears in Appendix C.

Batting averages were calculated from data collected by the investigator during the 1994 summer season. The investigator gathered data for each subject from at least four and not more then nine games. The experimenter selected the games included in the study. Subjects had no prior knowledge of games to be used for data collection. Any player who played in less than four games and had fewer than 10 plate appearances was excluded from the study. Playoff games were not included nor was the first game of the season. Batting averages were calculated using the following formula.

$$BA = \frac{hits}{at\text{-}bats}$$

where *BA* is batting average, *hits* is number of official hits, and *at-bats* is the number of plate appearances not including walks and sacrifices. Fielder's errors and fielder's choice (a putout or attempted putout on another runner) counted as an at-bat but not a hit.

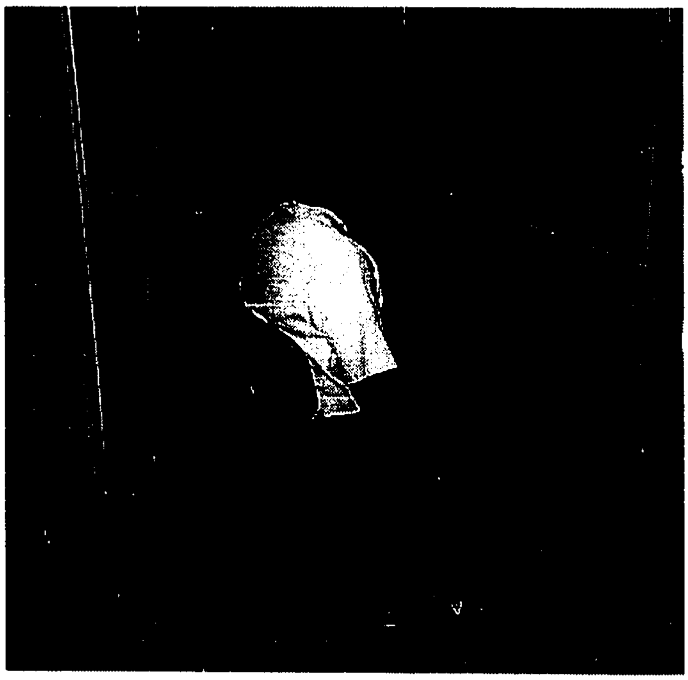
Procedures

Upon arriving at the laboratory subjects were given an introduction to the laboratory and a brief explanation of testing procedures. If there were no objections subjects were given an informed consent form and a health/activity history questionnaire (Appendix D). An opportunity for questions from subjects was provided. Once subjects read and understood their rights as subjects, they were informed of the format of the two tests. Testing followed a protocol schedule described in Appendix E. Prior to testing, subjects were taken to the Broca plane to measure height in centimeters and then to the platform balance scale to measure weight in kilograms. The order of the two test situations were as follows: (a) receptor anticipation timing, and (b) anaerobic power. Subjects were given 2 min to rest between tests.

Figure 2 depicts the anticipation timing test. While seated at the BAT subjects were read instructions for the test. Subjects were seated perpendicular to the BAT with the final light directly in front of the midline of the body. A seated position rather than a standing one was used to keep fatigue to a minimum. All subjects were right-handed batters and viewed the movement of the lights from left to right as they would view an oncoming pitch. An amber warning light with a variable foreperiod between 1.0 and 3.0 s signified subjects to prepare for the next trial. Five practice trials were given in order to familiarize the subject with the apparatus. The test consisted of 4 blocks of 16 trials. After each trial,

Figure 2

Set-up of Bassin Anticipation Timer

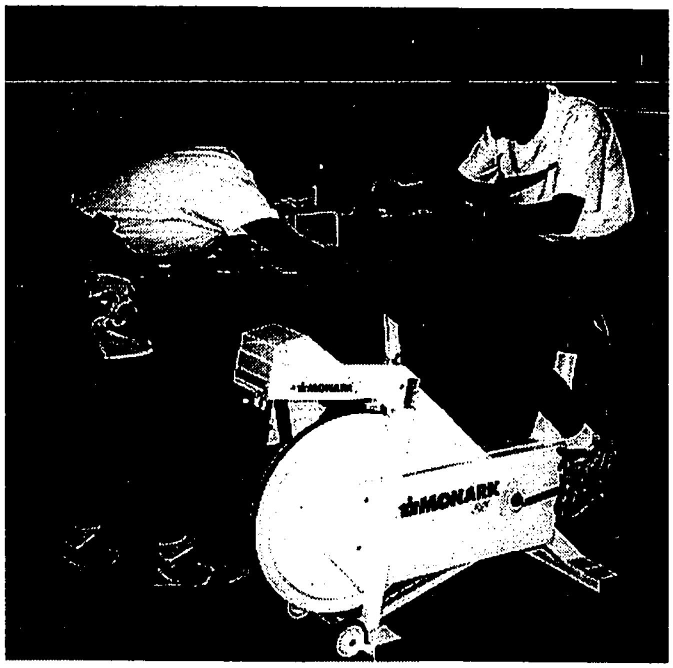


subjects were given knowledge of results as described in Appendix F. The subjects were instructed to use the thumb of the dominant hand to depress the response button when they anticipated the final light illuminating. Four speeds were presented: 224, 358, 626, and 760 cm•s^{-1} (5, 8, 14, and 17 mph). The slowest speed of 224 cm•s^{-1} was used because it has approximately the same viewing time (1.5 s) as a pitch in slow pitch softball. However, in the field a pitch is moving at a faster speed over a longer distance. The fastest speed of 760 cm•s^{-1} was the approximate speed of a pitch in slow pitch softball. The speed of 920 cm•s^{-1} was not used as it was generally too fast of a speed for humans to properly view and appeared as a blur of red lights on the BAT. The order of foreperiod time and speed was determined using the table of random numbers and the schedule appears in Appendix G. Between blocks of trials subjects were given the opportunity to rest for one min. The investigator recorded the time from the digital readout on the experimenter's control box and calculated constant, variable, and absolute error.

Anaerobic power was measured using the Wingate Anaerobic Test and is depicted in Figure 3. Prior to the start of the test subjects were verbally given instructions for the test. The seat of the cycle ergometer was adjusted so that the subject's legs were near full extension while when the pedal was in the down most position. The test was preceded by a standardized warm-up consisting of 4 min of pedaling against zero resistance interspersed with two to three sprints of 4 to 5 s (Bar-Or, 1978). After the warm-up subjects rested for 1 min while the procedures were reviewed. At this time toe clips were secured, handlebars adjusted to the subject's preference, and they were instructed not to stand-up during the test. At the command "GO" subjects began pedaling as fast as

Figure 3

Set-up of Wingate Anaerobic Test



possible. The investigator increased the resistance to 75 g•kg BW^{-1} within the first 2 to 3 s. As soon as the workload was set the 30 s test began. Subjects were verbally encouraged to give maximal effort without reference to time remaining in the test. A 2 to 4 min cool-down followed the test to decrease risk of muscle soreness and dizziness (Thorland, Johnson, Cisar, Housh, & Tharp, 1987). Anaerobic peak power output was calculated as the highest output in a 5 s work period (Bar-Or, 1978).

Analysis of Data

The data were entered into the Statistical Package for the Social Sciences (SPSSPC+). Analysis of data included a stepwise method multiple regression analysis with the criterion variable of batting average and the predictor variables of anticipation timing accuracy (constant, variable, and absolute error) and anaerobic power output (peak and mean power, fatigue index, and total work). A Pearson product moment correlation matrix including alpha levels was generated in order to examine the relationships among all variables. The highest alpha level reported was $p < .10$. Descriptive statistics of age, height, and weight were used to describe demographic characteristics of the subjects. Self-reported playing experience was also used to describe subjects.

Chapter 4

RESULTS AND DISCUSSION

The purpose of the study was to determine the extent to which receptor anticipation timing and anaerobic power contribute to batting performance in slow pitch softball. The following chapter reports the results and discussion of the investigation. Listings of data collected appear in Appendix H.

Subjects

Subjects were recruited from a women's slow pitch softball league that was designated level "C" by the Amateur Softball Association. The age of the subjects ranged from 26 to 43 years with an average of 32 ± 5 years. Self-reported playing experience ranged from 1 to 20 years. Only six subjects reported not having any fast pitch softball experience. Of the remaining 13 subjects, fast pitch softball experience ranged from 2 to 8 seasons primarily during high school and college. Eleven subjects reported playing in two slow pitch softball games per week when softball was in season. Infielders outnumbered outfielders 10 to 7 with only two subjects playing both infield and outfield positions on a regular basis.

Batting statistics were collected during the City of San Jose's 1994 10-game summer season. Subjects were not informed of which games were targeted for the study. Playoff games were excluded from the study. The number of at-bats ranged from 8 to 21 with the average of 15 (± 3). The number of hits ranged from 1 to 10 with the average of 6 (± 2). Batting averages ranged from .750 to .100 with an average of .360 (± .156). Carriero (1984) noted that in slow pitch softball batting averages of .500 are common. This was not the case in the present study as only two subjects had batting averages above .500.

Anticipation Timing

Visual inspection of the data yielded no differences in any error score among the four speeds presented. This is contrary to the inverted-U relationship previously mentioned that noted that slower speeds may present higher error scores compared with faster speeds. Newell, Carlton, Carlton, and Halbert (1980) found increased timing error with speeds of 5 and 25 $cm \bullet s^{-1}$ versus faster speeds of 150 and 225 $cm \bullet s^{-1}$. It is possible that the present study did not use speeds that were different enough from one another to yield differences in timing error.

Anticipation Timing and Batting Performance

Utilizing a Pearson product moment correlation (refer to Table 2 for correlation matrix), none of the anticipation timing dependent variables (constant, variable and absolute error) were significantly related to batting average. The correlation coefficients were .018, -.166, and .003 for constant, variable, and absolute error, respectively. In order to be a successful hitter in slow pitch softball, one must be able to make optimal contact of the bat with the ball. Many factors influence one's batting performance. Mikel (1984) found a strong relationship ($r = -.75$, $p < .001$) between anticipation timing error and baseball batting performance. However, if a batter is given more than 1 s to respond to a pitch, it is logical to conclude that reaction time does not play a significant role in batting.

However, movement time may play an important role. Decreased movement time means an increase in bat speed. This is important because of the slow speed of the pitch. The estimation of one's own movement time is one component of receptor anticipation timing. The present study did not use a

Table 2

Correlation Matix

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Batting average	1.00										
2. Absolute peak power	.60**	1.00									
3. Relative peak power	-.07	-.08	1.00								
4. Absolute mean power	.55*	.89***	.05	1.00							
5. Relative mean power	-.07	-.16	.92***	.14	1.00						
6. Absolute work	.55*	.89***	.05	1.00***	.13	1.00					
7. Relative work	-.08	-.17	.92***	.13	.99***	.13	1.00				
8. Fatigue index	.13	.29	-.37	-.12	-.65**	-.12	-.66**	1.00			
9. Constant error	.02	.11	.02	.10	.01	.10	-.01	-.07	1.00		
10. Variable error	-.17	.12	-.42•	.01	-.43•	.01	-.43•	.39•	.26	1.00	
11. Absolute error	.00	.17	-.36	.09	-.35	.09	-.35	.37	-.27	.82***	1.00

Significance levels: *** - p<.001, ** - p<.01, * - p<.02, • - p<.10

ballistic response similar to striking a moving target. Only a hand-held response button was used which required thumb movement. This is considerably less movement than the full body ballistic response required during softball batting. Wrisberg, Hardy, and Bietel (1982) examined the accuracy of a ballistic coincidence anticipation response. A BAT was used and the speeds presented were 134, 224, and 313 cm•s^{-1}. A ballistic arm response occurred over three distances: 43, 73, and 103 cm. It was found that constant error had the highest relationship to movement velocity during the slow and moderate stimulus velocities and at the short and intermediate movement distances. During fast movement velocities, variable error was most highly related to movement velocity. In the present study the highest correlation achieved was only -.166 between variable error and batting average and it was not significant. It is possible that the present study did not replicate the task of batting effectively and therefore no relationship was found.

It is also possible that the BAT did not properly simulate the speed of a pitch in slow pitch softball. In an actual game a pitch occurs over 15.24 m with a white 27.94 cm ball at approximately 920 cm•s^{-1}. The BAT is 295 cm in length and used small red lights that only give the illusion of movement. Only a blur of red lights appear when the BAT is set at too fast a speed.

Anaerobic Power

Absolute peak power output ranged from 422 to 662 watts. Relative peak power ranged from 9.0 to 5.6 watts•kg BW^{-1}. Absolute mean power output ranged from 320 to 510 watts. Relative mean power ranged from 7.0 to 3.8 watts•kg BW^{-1}. Fatigue index ranged from 34 to 56 %. Refer to Table 3 for mean scores. The Pearson product moment correlation between absolute peak and mean power was $r = .89$ ($p < .001$). Fatigue index had a significant correlation with relative mean power ($r = .65$, $p < .01$).

In Table 3 a comparison of Wingate results among female subjects is shown. Maud and Shultz (1989) examined Wingate performance of 69 females in order to establish norms. Subjects ranged from 18 to 28 years of age and all were college students. Average absolute mean power was 380.8 ± 56.4 watts. In the present study average mean power was 396.11 ± 55.97 watts. This average score in the present study would be in the 60th percentile rank in the Maud and Shultz study. Average absolute peak power was 454.5 ± 81.3 watts in the Maud and Shultz study and 530.53 ± 73.60 in the present study. The average absolute peak power score in the present study would be in the 85th percentile rank in the Maud and Shultz study. Curby and Glimco (1989) examined the anaerobic responses of 16 and 17 year old high school students while Bradley (1991) tested eight female college fast pitch softball players utilizing the Wingate Anaerobic Test. The aforementioned studies used a resistance of 75 g•kg BW^{-1}.

Of these studies the college softball players (Bradley, 1991) had the highest relative peak power output while the present study produced the lowest score. This could be due to the present study utilizing subjects that were older and possibly heavier. The same could hold true for the present study having the lowest relative mean power output. However, when comparing absolute peak and mean power the present study did not produce the lowest score.

Anaerobic Power and Batting Performance

Utilizing a Pearson product moment correlation, two of the anaerobic indices were significantly related to batting average. The strongest relationship

Table 3

<u>Comparison of Wingate Anaerobic Test Results Among Females</u>

Study	N	Peak Power (watts)	Peak Power (w•kg BW^{-1})	Mean Power (watts)	Mean Power (w•kg BW^{-1})	Fatigue Index (%)
Present Study	19 recreational players	530±72.6	7.77±1.04	396.11±55.97	5.83±0.94	46.26±6.0
Maud & Shultz (1989)	69 college students	454.5±81.3	7.61±1.24	380.8±56.4	6.35±0.73	35.05±8.32
Curby & Glimco (1989)	81 high school P.E. students		8.1		6.2	44
Bradley (1991)	8 college softball players	639.74±67.5	9.93±0.95			

was found with absolute peak power output and batting average ($r = .60$, $p < .01$). Batting in slow pitch softball requires a ballistic motor response and therefore it is logical to conclude that anaerobic power would play an important role. This was demonstrated in the present study. Batting averages are based upon one's ability to hit. Generally, a batted ball needs to get beyond the infield in order to become a hit. This requires a certain amount of force to be generated by the hitter.

It was also noted that absolute mean power and batting average were significantly related ($r = .55$, $p < .02$). Refer to Figures 4 and 5 for a scatterplot between batting average and absolute peak and mean power output. This relates back to one's ability to produce a high power output over a short period of time. However, it was interesting to note that relative peak and mean power showed no significant relationships with batting average. According to this study, a person with a high relative power output may not necessarily have a high batting average. For example, one subject in the study scored above average in relative peak power (8.5 watts•kg BW^{-1}) but below average in absolute peak power (435 watts). This subject had the lowest batting average (.100). Compare this with the subject who had the highest batting average (.750) who scored 8.8 watts•kg BW^{-1} in relative peak power and 662 watts in absolute peak power. In this study the amount of power produced was more important than body size.

Batting averages may also be influenced by running speed. In a race to first base, some softball players are able to beat the throw because they are fast sprinters. A slow sprinter with the same batting ability may be credited with an out rather than a hit for a given ground ball. It is a 19.81 m sprint to first base,

Figure 4

Scatterplot of Batting Average and Peak Power

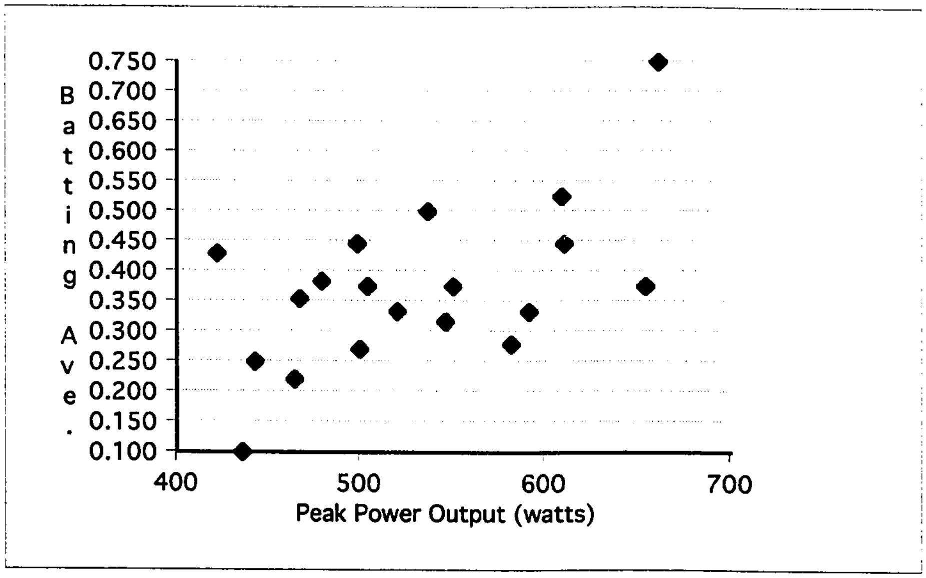
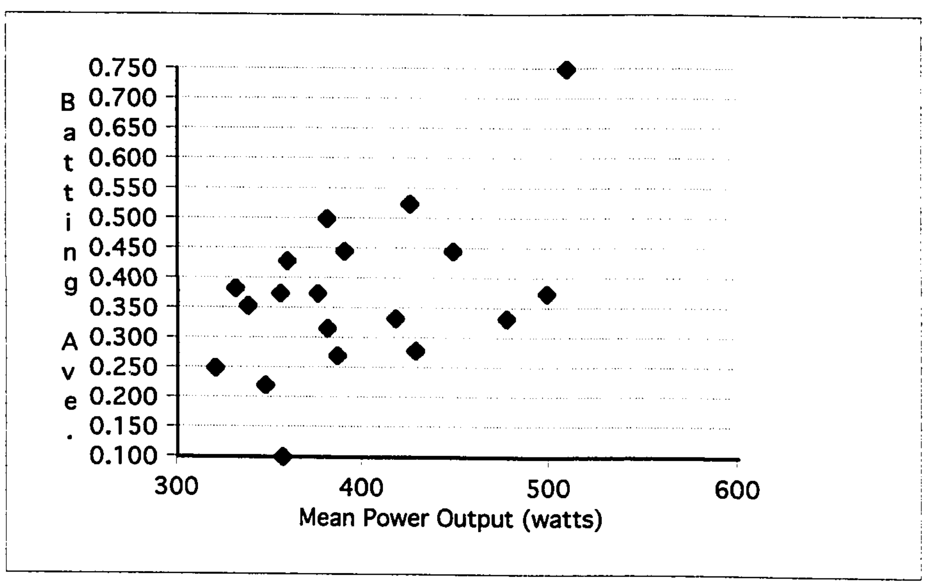


Figure 5

Scatterplot of Batting Average and Mean Power



however, sprinting ability was not tested in the present study. Perhaps slugging percentage would have been a more appropriate measure. This is where a batter is given one point for a single base hit, two points for a double, three points for a triple and four points for a home run. These points are then divided by the number of at-bats to produce slugging percentage. One's sprinting ability plays a role in the number of bases achieved.

Anticipation Timing and Anaerobic Power

The anticipation timing test required subjects to use space and time factors to predict a light illuminating. Only thumb movement was needed for the hand-held response button. In comparison, the anaerobic power test required less mental preparation but rather a great physiological demand. Although the two tests in the study were different, two relationships were found.

For the Bassin Anticipation Timer, variable error represents the consistency of the subjects' responses. Variable error showed a weak relationship with relative peak and mean power. Correlation coefficients were -.42 and -.44 ($p < .10$) for peak and mean power measured relative to body weight. Subjects who scored high in relative power output were more likely to show consistency in results during the anticipation timing test. No other anticipation timing error score demonstrated a relationship of significance with any anaerobic power score.

Predictor Variables and Batting Average

In an effort to examine the contributions of anticipation accuracy and anaerobic power to batting average, a multiple regression analysis was calculated. The stepwise method was utilized; however, no significant findings can be reported. The only variable able to make it in the equation was absolute peak power, however, the F statistic failed to reach significance.

This was expected as none of the anticipation timing error scores related to batting average. Of the anaerobic power scores, only absolute peak power was significant ($r = .60$, $p < .001$). The absence of significant findings can possibly be attributed to the low number of subjects, and inappropriate laboratory or field measures.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of the study was to determine the extent to which receptor anticipation timing and anaerobic power contribute to batting performance in slow pitch softball. This chapter contains the summary, conclusions, and recommendations for future study.

Summary

Subjects were measured for receptor anticipation timing and anaerobic power to determine the contributions to batting performance in slow pitch softball. Receptor anticipation timing was measured using a Bassin Anticipation Timer while anaerobic power was measured using the Wingate Anaerobic Test. Batting averages were collected by the investigator during a 10 game summer slow pitch softball season. Nineteen female softball players were tested for the study.

The first null hypothesis tested was that receptor anticipation timing does not contribute to slow pitch softball batting performance. The null hypothesis was accepted as no significant relationships were found between anticipation timing error scores and batting average.

The second null hypothesis tested was that anaerobic power does not contribute to slow pitch softball batting performance. The null hypothesis was rejected as two significant relationships were found. The strongest relationship was found between absolute peak power and batting average ($\underline{r} = .60$, $\underline{p} < .01$). The relationship between absolute mean power and batting average was .55 ($\underline{p} < .02$). This was logical to conclude as ballistic movements involve anaerobic energy systems. However, it was interesting to note that when peak and mean power were measured relative to body weight, no significant relationships were found with batting average ($p > .10$). The same holds true for fatigue index and total work performed ($p > .10$).

The final null hypothesis tested was that receptor anticipation timing and anaerobic power do not contribute to slow pitch softball batting performance. The null hypothesis was accepted as a multiple regression analysis failed to yield significant results.

Some weaknesses of the study were recognized. An increase in the number of subjects in the study would have been beneficial. It would have been interesting to compare players of different playing abilities and playing experiences. It is also possible that the present study did not properly replicate the task of batting. Many variables contribute to batting and only two variables were measured in the study.

Conclusions

According to the results of this study it was concluded that slow pitch softball players wishing to improve batting averages should focus on increasing anaerobic power output. It is possible that players should not spend time in increasing anticipation accuracy as this did not demonstrate any significant relationship with batting average in this study.

Recommendations for Future Study

1. Other comparisons can be made such as comparing male to female softball players and expert to novice playing experiences.
2. Batting average should be used in conjunction with other batting variables such as slugging percentage, runs batted in, and a hitting rating productivity chart in order to present a better picture of batting ability.

3. Future studies should also better replicate batting skills with receptor anticipation timing. The modified Bassin Anticipation Timer, model 31201 from Lafayette Instruments, utilizes an infrared beam where the goal is to break the beam at the same time the final light illuminates on the timer. Softball bats can be used.
4. Batting occurs in the frontal and transverse planes of movement; however, the Wingate Test occurs in the saggital plane. Future studies should attempt to measure the force of an actual bat swing.
5. Sprinting ability may play an important role in batting ability and needs to be examined.

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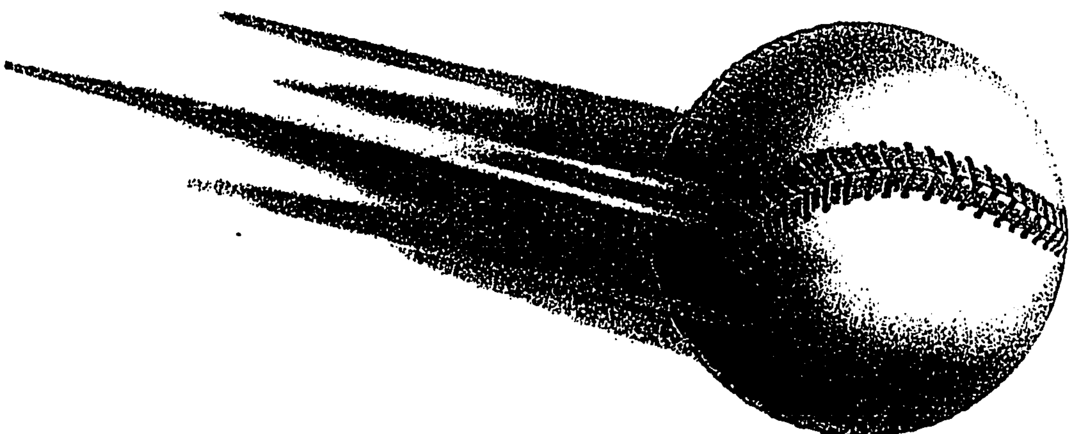
APPENDICES

Appendix A

FLYER USED FOR RECRUITMENT OF SUBJECTS

Thesis Project

Softball Players Needed



Selection Criteria

- ***Female, about 30 to 40 years old***
- ***At least 1 season of slow pitch softball experience***
- ***Participating in the 1994 slow pitch softball summer season***
- ***Apparently healthy***

Heidi A. York, candidate for a Master of Arts at San Jose State University, will be conducting research examining the relationship between anaerobic power and anticipation timing accuracy to slow pitch softball batting performance.

Testing Includes:
- Height/Weight
- Anaerobic Power
- Anticipation Timing

Laboratory testing will take approximately one hour and can be scheduled at your convenience. It will be held at San Jose State University.

Batting statistics will be gathered during regular season games during the 1994 summer season.

If you are interested in being a subject please call
Heidi at (408) 335-4108

Appendix B

A STUDY TO INVESTIGATE
THE CONTRIBUTIONS OF ANTICIPATION TIMING AND ANAEROBIC POWER
TO BATTING PERFORMANCE IN SLOW PITCH SOFTBALL

STATEMENT OF INFORMED CONSENT FOR TESTS OF
ANAEROBIC POWER, AND ANTICIPATION TIMING

Invitation to Participate

You are invited to participate in a study to investigate the relationship between anaerobic power, and anticipation timing to batting in slow pitch softball. The study will be conducted during the 1994 softball season at San Jose State University under the direction of the Department of Human Performance. Batting statistics will be collected during selected regular season games.

Basis for selection

You have been selected to participate in this study based on the following criteria: (a) you are a healthy adult female familiar with the game of slow pitch softball, (b) you have at least 1 year of playing experience, (c) you will be participating in the 1994 softball season, (d) you are not prone to epileptic seizures, and (e) you have freely volunteered without being coerced.

Explanation of Procedures

The testing procedures will be supervised by Carol L. Christensen, Ph.D.,

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and Heidi A. York, Master's degree student. Specific instructions for each test situation will be given prior to the test. Feel free to ask questions at any time.

Anticipation Timing Test

The anticipation timing test will involve the Bassin Anticipation Timer. This device is a runway of lights that will light up one after the other. You will be seated perpendicular to the runway near the end and be required to depress a button at the time you anticipate the last light going on. You will be given five practice trials to become familiar with the test situation. The test will consist of 4 blocks of 16 trials each.

(approximately 40 minutes)

Anaerobic Power Test

The anaerobic power test will consist of pedaling on a stationary cycle ergometer against resistance as fast as possible for 30 s. A warm-up period will precede the test as well as a cool-down period following. The cycle is fitted with an adjustable seat to assure individual comfort. Toe-clips will provide additional stability and reduce the risk of slipping off the pedals. On the command "GO" you will begin pedaling as fast as possible while the resistance will be set within 3 s. Resistance is based upon your body weight.

(approximately 10 minutes)

Additional Information to be Gathered

Field measurements consisting of batting performance will be gathered during the 1994 softball season. At least 10 plate appearances will be used to determine batting average.

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Discomforts and Risks

During the Anaerobic Power test some individuals may strain muscles in the leg from improper warm-up. This is unlikely as a warm-up period will precede the test. Another possible risk may be temporary fatigue from a maximal effort. Some discomforts may include increased heart rate, increased breathing rare, elevated body temperature, sweating, muscle soreness, and fatigue.

During the Anticipation Timing test the flashing lights may increase the risk of seizure to those prone to epileptic seizures.

Benefits from Participation in the Study

You will benefit from this study by receiving information regarding batting average, anticipation timing accuracy, and anaerobic power. The results of this investigation will quantify some aspects concerning your batting performance in slow pitch softball. You may use this information to improve your batting performances and influence current batting practice sessions.

Assurance of Confidentiality

The data generated from this research may be used for scientific purposes including publication and presentation at professional meetings. Your identity or individual test results will not be revealed in published or presented papers without your written consent.

Withdrawal of Consent

You may withdraw your consent and discontinue participation in the study at any time (including during the test) without prejudicing your relationship with the Department of Human Performance, San Jose State University, or the City of

*after reading this page please initial here:*_____

San Jose Community Sports Program. If you have any questions regarding the investigation at this time or during the test, please feel free to ask. For questions or complaints that may come up later call Heidi A. York (408) 335-4108 or Dr. Carol L. Christensen, Department of Human Performance, (408) 924-3035. You may also contact Dr. James Bryant, Chair of the Department of Human Performance, (408) 924-3010. For questions or complaints about subject's rights or in the event of research related injury, contact Dr. Serena Stanford, Associate Academic Vice President of Graduate Studies and Research, (408) 924-2480.

Consent

Having read the above, I agree:

(a) that my consent is given voluntarily without being coerced,

(b) that to participate in the study, procedures will be verbally explained to me knowing that there are some discomforts and/or risks,

(c) that I understand I can withdraw from the study at any time, and

(d) that I understand the data are confidential but may be published or presented without revealing my identity except with my express consent.

MY SIGNATURE INDICATES THAT I HAVE DECIDED TO PARTICIPATE IN THIS STUDY, HAVING READ THE INFORMATION PROVIDED ABOVE AND THAT I HAVE RECEIVED A COPY OF THIS CONSENT FORM.

SIGNATURE______________________________DATE__________

PRINT NAME____

SIGNATURE
OF WITNESS_______________________________________

SIGNATURE OF
INVESTIGATOR_____________________________________

Appendix C

SAMPLE PRINTOUT FROM SMI POWER™ SOFTWARE PROGRAM

Test Summary

Name: Example | Mass: 53.5 kg | Gender: F
Date: 09-11-94 | File: Example0.DAT

Time (s)	Force (kg)	RPM	Power (watts)	Power (watts/kg)
0:01	4.00	461	487	9.1
0:02	4.00	442	467	8.7
0:03	4.00	439	463	8.7
0:04	4.00	431	455	8.5
0:05	4.00	428	452	8.4
0:06	4.00	424	448	8.4
0:07	4.00	420	443	8.3
0:08	4.00	405	428	8.0
0:09	4.00	386	407	7.6
0:10	4.00	375	396	7.4
0:11	4.00	356	376	7.0
0:12	4.00	338	357	6.7
0:13	4.00	322	340	6.4
0:14	4.00	322	340	6.4
0:15	4.00	315	333	6.2
0:16	4.00	304	321	6.0
0:17	4.00	300	317	5.9
0:18	4.00	292	308	5.8
0:19	4.00	278	293	5.5
0:20	4.00	270	285	5.3
0:21	4.00	270	285	5.3
0:22	4.00	274	289	5.4
0:23	4.00	262	277	5.2
0:24	4.00	262	277	5.2
0:25	4.00	255	269	5.0
0:26	4.00	255	269	5.0
0:27	4.00	248	262	4.9
0:28	4.00	251	265	5.0
0:29	4.00	232	245	4.6
0:30	4.00	229	242	4.5
Averages:		328	347	6.5

Maximum Power: 465 watts or 8.7 watts/kg
Minimum Power: 257 watts or 4.8 watts/kg
Fatigue Index: 44.7%
Total work: 10,396 joules or 194 joules/kg

Appendix D

A STUDY TO INVESTIGATE

THE CONTRIBUTIONS OF ANTICIPATION TIMING AND ANAEROBIC POWER

TO BATTING PERFORMANCE IN SLOW PITCH SOFTBALL

HEALTH HISTORY AND ACTIVITY QUESTIONNAIRE

Personal Information

Name____________________ Age______________

Address________________________________

City____________________ Zip______________

Day Phone______________ Evening Phone____________

Medical Information

Past History - In the past have you ever had:

- ❑ Heart Attack or stroke
- ❑ Heart surgery
- ❑ Disease of arteries
- ❑ Injuries to back, knees, ankles
- ❑ Allergic reactions
- ❑ Asthma
- ❑ Unusual dizziness
- ❑ Anemia
- ❑ Elevated cholesterol
- ❑ Rheumatic fever
- ❑ Heart rhythm problems
- ❑ Varicose veins
- ❑ Epilepsy or convulsions
- ❑ Tuberculosis
- ❑ Arthritis
- ❑ Fainting spells
- ❑ Thyroid problems
- ❑ Hernias
- ❑ Heart murmur
- ❑ High blood pressure
- ❑ Lung disease
- ❑ Diabetes
- ❑ Bronchitis
- ❑ Abnormal chest X-ray
- ❑ Scarlet fever
- ❑ Urinary tract problems
- ❑ ***NONE OF THE ABOVE***

Family History - Have any blood relatives had:

- ❑ Heart attack under age 50
- ❑ High blood pressure
- ❑ Congenital heart disease
- ❑ Other:
- ❑ Strokes under age 50
- ❑ High cholesterol
- ❑ Asthma or hay fever
- ❑ Other:
- ❑ Heart operations
- ❑ Diabetes
- ❑ Obesity
- ❑ ***NONE OF THE ABOVE***

Present Symptoms - Have you recently (in the past 6 months) had:

- ❑ Chest pain or pressure
- ❑ Light headedness
- ❑ Back pain
- ❑ Awakened short of breath
- ❑ Chronic muscle soreness
- ❑ Shortness of breath
- ❑ Cough on exertion
- ❑ Arthritis
- ❑ Loss of consciousness
- ❑ Other:
- ❑ Heart palpitations
- ❑ Coughing up blood
- ❑ Swollen legs
- ❑ Joint soreness
- ❑ ***NONE OF THE ABOVE***

Please explain any conditions checked above (specific condition, date of event, etc.).

____

____

Please list prescribed or self-prescribed medications you now take.

____

____

Date of last complete physical exam (month, year):____ ______ or ❑ can't remember

Date of last electrocardiogram (ECG) (month, year):________ or ❑ can't remember

Were any of the above abnormal? ❑ Yes ❑ No

Have you ever had any major chronic skeletal or muscular injuries?

❑ Yes ❑ No If yes, please explain: ______________________________

____

____

Lifestyle Information

Are you currently involved in a regular exercise program? ❑ Yes ❑ No

If yes indicate type of activity and number of days per week:

Activity_______________________ **Days/week** _______________________

_______________________ _______________________

_______________________ _______________________

Do you regularly engage in aerobic activity (e.g., walking, running, cycling, swimming, aerobic dance, etc.) for 20 minutes or longer at least 3 days each week? ❑ Yes ❑ No

How would you describe your general health?

❑ poor ❑ fair ❑ average ❑ good ❑ excellent

Have you ever been advised by a physician not to exercise because of a medical problem? ❑ Yes ❑ No If yes, please explain:

____

____

Please explain any other significant medical problem that you consider important for us to know: ______________________________________

____

____

Softball History

At what age did you first begin to play softball? ____________

Please list your participation in the following (in years):

youth baseball/softball	__________________
high school fast pitch	__________________
college fast pitch	__________________
modified fast pitch	__________________
coed slow pitch	__________________
women's slow pitch	__________________
other:	__________________
other:	__________________

When softball is in season how many games per week do you usually participate in: ___________games/week.

Where in the batting order are you usually placed? (circle one of the following)

1-2 3-4 5-6 7-8 9-11

Are you primarily (circle one) left-handed or right-handed?

Do you normally bat (circle one) left-handed or right-handed?

What defensive position do you usually play? (circle one of the following)

P C 1B 2B 3B SS LF LCF RCF RF

Within the last year approximately how many softball tournaments did you participate in?___________

Do you frequently participate in other competitive sports? ❑ Yes ❑ No

If yes indicate sport and number of days per week:

Sport		Days/week	
	________________________		________________________
	________________________		________________________
	________________________		________________________

Appendix E

PROTOCOL SCHEDULE

Time	Action
0	Subject arrives
0-2	Brief introduction to lab & experiments
2-12	Questionnaire & informed consent
12-15	Height and weight
15-18	Introduction to BAT and practice trials
18-48	Anticipation timing test
48-50	Rest
50-54	Introduction to Wingate and warm-up
54-58	Anaerobic power test and cool-down
58-60	Answer questions, thank Subject, escort Subject out
60	Subject leaves

Appendix F

KNOWLEDGE OF RESULTS FOR BASSIN ANTICIPATION TIMER TEST

Error	Knowledge of Results
0	"Excellent! That was perfect"
.001-.020 s	"Very Good. That was right there"
.021-.050 s	"Good. That was just a little (early/late)"
.051-.099 s	"You were (early/late) on that one"
.100 s and above	"You were somewhat (early/late)"

Appendix G

A STUDY TO INVESTIGATE

THE CONTRIBUTIONS OF ANTICIPATION TIMING AND ANAEROBIC POWER

TO BATTING PERFORMANCE IN SLOW PITCH SOFTBALL

DATA COLLECTION SHEET

Subject number__________ Age________ Date________

Height____________cm Weight____________kg Time________

Wingate Test of Anaerobic Power

Computer will print results of test and calculate power output.

Resistance used_________ Fatigue Index____________%

Maximum power_________watts•kg^{-1} BW and ____________watts

Minimum power_________watts•kg^{-1} BW and ____________watts

Mean power_____________watts•kg^{-1} BW and ____________watts

Total work______________joules•kg^{-1} BW and ____________joules

Bassin Anticipation Timer Test for Anticipation Accuracy

Experimenter's control box will show amount of error where (-) indicates an early response and (+) indicates a late response.

Five Practice Trials

Trial	*Foreperiod*	*Speed*	*Result*
1	3.0 s	14 mph	____________
2	2.0	8	____________
3	1.0	17	____________
4	1.5	5	____________
5	2.5	8	____________

Bassin Anticipation Timer Results

Trial	Fore-period	Speed	Block 1 Results	Fore-period	Speed	Block 2 Results	Fore-period	Speed	Block 3 Results	Fore-period	Speed	Block 4 Results
1	2.0	5		1.5	8		1.5	17		2.5	8	
2	3.0	14		1.0	14		2.0	17		1.5	17	
3	3.0	8		2.5	17		1.5	8		2.5	14	
4	1.5	5		2.5	17		2.0	8		1.5	14	
5	1.0	17		1.0	14		1.0	5		1.5	8	
6	3.0	8		2.0	5		1.0	5		3.0	5	
7	1.5	14		3.0	5		1.0	8		3.0	5	
8	1.5	8		1.0	14		2.0	14		2.5	17	
9	3.0	5		2.5	8		1.5	5		2.5	17	
10	1.5	5		1.5	17		1.5	5		1.5	8	
11	2.0	14		1.0	5		2.0	17		1.5	5	
12	1.0	5		2.5	17		2.0	8		2.5	8	
13	1.5	17		2.0	5		3.0	5		3.0	14	
14	3.0	5		1.0	8		3.0	14		1.0	8	
15	1.0	17		2.0	5		2.0	5		2.5	17	
16	1.5	8		1.5	14		1.0	8		3.0	5	

foreperiod in s; speed in mph

Appendix H

DATA COLLECTED

ID	Age(yrs)	Height(cm)	Weight(kg)	At-bats	Hits	Batting Ave.
101	29	156	59	12	3	.250
103	32	161	96	19	10	.526
105	41	156	57	16	6	.375
107	35	168	67	14	7	.500
108	39	163	63	19	6	.316
109	35	163	89	18	6	.333
110	32	151	52	21	9	.429
111	43	171	92	16	6	.375
113	37	170	86	13	5	.385
114	28	171	71	11	3	.273
115	34	174	66	12	4	.333
116	29	161	77	18	8	.444
120	39	159	71	18	8	.444
121	27	158	52	10	1	.100
122	26	163	66	18	5	.278
123	27	174	88	8	3	.375
124	38	156	52	17	6	.353
126	28	167	76	12	9	.750
127	26	168	53	18	4	.222
M =	33.89	163.68	70.16	15.26	5.74	.360
SD =	5.48	6.73	14.58	3.65	2.40	.156

Wingate Anaerobic Test

	Peak Power Output		Mean Power Output		Fatigue Index
ID	watts	watts•kg	watts	watts•kg	%
101	443	7.6	320	5.5	47
103	609	6.4	426	4.5	56
105	504	8.8	376	6.6	46
107	537	8.1	381	5.8	51
108	547	8.7	381	6.0	46
109	592	6.7	477	5.4	43
110	422	8.1	359	6.9	34
111	551	6.0	355	3.9	54
113	479	5.6	331	3.8	56
114	500	7.1	386	5.5	44
115	520	7.9	418	6.3	36
116	611	8.0	448	5.9	47
120	499	7.1	390	5.6	42
121	435	8.5	357	7.0	41
122	582	9.0	428	6.6	52
123	655	7.5	498	5.7	46
124	467	9.0	338	6.5	50
126	662	8.8	510	6.8	44
127	465	8.7	347	6.5	44
M =	530.53	7.77	396.11	5.83	46.26
SD =	72.60	1.04	55.97	.94	6.00

Anticipation Timing Test

ID	Constant	Error Variable	Absolute
101	-.020 s	.044 s	.033 s
103	-.005	.058	.045
105	.002	.059	.047
107	-.006	.062	.051
108	-.002	.057	.044
109	-.007	.061	.050
110	-.014	.033	.027
111	-.023	.050	.045
113	-.048	.065	.067
114	-.016	.055	.049
115	-.022	.031	.030
116	-.032	.044	.041
120	-.006	.050	.039
121	-.041	.066	.065
122	-.029	.045	.040
123	.004	.065	.052
124	-.013	.034	.030
126	-.045	.031	.046
127	-.026	.037	.038
M =	-.018	.050	.044
SD =	.016	.012	.011